National Institute of Environmental Health Sciences

Modelling malaria incidence with environmental dependency in a locality of Sudanese savannah area, Mali

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Abstract:

BACKGROUND: The risk of Plasmodium falciparum infection is variable over space and time and this variability is related to environmental variability. Environmental factors affect the biological cycle of both vector and parasite. Despite this strong relationship, environmental effects have rarely been included in malaria transmission models.Remote sensing data on environment were incorporated into a temporal model of the transmission, to forecast the evolution of malaria epidemiology, in a locality of Sudanese savannah area. METHODS: A dynamic cohort was constituted in June 1996 and followed up until June 2001 in the locality of Bancoumana, Mali. The 15-day composite vegetation index (NDVI), issued from satellite imagery series (NOAA) from July 1981 to December 2006, was used as remote sensing data.The statistical relationship between NDVI and incidence of P. falciparum infection was assessed by ARIMA analysis. ROC analysis provided an NDVI value for the prediction of an increase in incidence of parasitaemia.Malaria transmission was modelled using an SIRS-type model, adapted to Bancoumana's data. Environmental factors influenced vector mortality and aggressiveness, as well as length of the gonotrophic cycle. NDVI observations from 1981 to 2001 were used for the simulation of the extrinsic variable of a hidden Markov chain model. Observations from 2002 to 2006 served as external validation. RESULTS: The seasonal pattern of P. falciparum incidence was significantly explained by NDVI, with a delay of 15 days (p Euro Surveillance (Bulletin Europeen Sur Les Maladies Transmissibles; European Communicable Disease Bulletin) 0.001). An NDVI threshold of 0.361 (p Euro Surveillance (Bulletin Europeen Sur Les Maladies Transmissibles; European Communicable Disease Bulletin) 0.007) provided a Diagnostic Odd Ratio (DOR) of 2.64 (CI95% [1.26;5.52]).The deterministic transmission model, with stochastic environmental factor, predicted an endemo-epidemic pattern of malaria infection. The incidences of parasitaemia were adequately modelled, using the observed NDVI as well as the NDVI simulations. Transmission pattern have been modelled and observed values were adequately predicted. The error parameters have shown the smallest values for a monthly model of environmental changes. CONCLUSION: Remote-sensed data were coupled with field study data in order to drive a malaria transmission model. Several studies have shown that the NDVI presents significant correlations with climate variables, such as precipitations particularly in Sudanese savannah environments. Non-linear model combining environmental variables, predisposition factors and transmission pattern can be used for community level risk evaluation.

Source: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2686729

Resource Description

Early Warning System:

resource focus on systems used to warn populations of high temperatures, extreme weather, or other elements of climate change to prevent harm to health

A focus of content

Exposure :

weather or climate related pathway by which climate change affects health

Ecosystem Changes, Precipitation

Geographic Feature:

resource focuses on specific type of geography

Other Geographical Feature

Other Geographical Feature : savannah

Geographic Location:

resource focuses on specific location

Non-United States

Non-United States: Africa

African Region/Country: African Country

Other African Country: Mali

Health Impact:

specification of health effect or disease related to climate change exposure

Infectious Disease

Infectious Disease: Vectorborne Disease

Vectorborne Disease: Mosquito-borne Disease

Mosquito-borne Disease: Malaria

Mitigation/Adaptation:

mitigation or adaptation strategy is a focus of resource

Adaptation

Model/Methodology:

type of model used or methodology development is a focus of resource

Exposure Change Prediction

Resource Type:

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Short-Term (

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content